

April 13, 2006

Certified Mail
Return Receipt Requested

Ms. Tamera M. Thompson
Director, Office of Air Permit Programs
Department of Environmental Quality
P. O. Box 10009
Richmond, Virginia 23240

Subject: BART Exemption Modeling Protocol
I.D. No. 093-00006 / Registration No. 60214

Dear Ms. Thompson:

This letter is in response to your correspondence to our facility dated February 15, 2006, regarding BART exemption modeling, Information Request, and Resource Update. Please find enclosed International Paper's Source-Specific BART Exemption and Determination Modeling Protocol. International Paper has opted to perform exemption modeling as allowed by EPA to determine if the aggregate emissions impact of our BART eligible sources fall below the visible contribution threshold of 0.5 deciviews (dv). International Paper's modeling protocol was prepared by ENSR Corporation. It includes the following:

- 1.0 Introduction
- 2.0 Source Description and Emissions Data
- 3.0 Input data to the CALPUFF model
- 4.0 Air quality modeling procedures
- 5.0 Presentation of modeling results

Appendix A Source-specific Emissions Data for BART Baseline Case

Appendix B Source-Specific Emissions Data for BART Determination Options



I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or systems, or those persons directly responsible for gathering and evaluating the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

If you have any questions regarding this submittal, you may call Sheryl Raulston at (757) 569- 4558.

Sincerely,



John W. Rankin
Mill Manager

Cc: Jaime Bauer – DEQ Richmond Office
Laura Corl – DEQ Tidewater Regional Office
Jane Workman – DEQ Tidewater Regional Office

Enclosure



Prepared for:
International Paper
Franklin, Virginia

Source-Specific BART Exemption and Determination Modeling Protocol: International Paper – Franklin, VA

ENSR Corporation
April 2006
Document No.: 06890-435-100

Prepared for:
International Paper
Franklin, Virginia

Source-Specific BART Exemption and Determination Modeling Protocol: International Paper – Franklin, VA



Prepared by: Robert Iwanchuk



Reviewed by: Robert Paine

ENSR Corporation
April 2006
Document No.: 06890-435-100

Contents

1.0 Introduction.....	1-1
1.1 Objectives	1-1
1.2 Location of source vs. relevant Class I Areas	1-1
1.3 Organization of protocol document.....	1-2
2.0 Source description and emissions data	2-1
2.1 Unit-specific source data.....	2-1
3.0 Input data to the CALPUFF model	3-1
3.1 General modeling procedures	3-1
3.2 Air quality database (background ozone and ammonia)	3-1
3.3 Natural conditions and monthly f(RH) at Class I Areas	3-2
4.0 Air quality modeling procedures	4-1
4.1 Model selection and features	4-1
4.2 Modeling domain and receptors	4-1
4.3 Technical options used in the modeling	4-1
4.4 Light extinction and haze impact calculations	4-1
5.0 Presentation of modeling results.....	5-1
Appendix A Source-Specific Emissions Data for BART Baseline Case	A-1
Appendix B Source-Specific Emissions Data for BART Determination Options (Reserved).....	B-1
Appendix C NCASI Particulate Emissions Data for Pulp and Paper Industry Specific Sources.....	C-1

List of Tables

Table 2-1	IP Franklin – Baseline BART Stack Parameters and Criteria Pollutant Emissions.....	2-2
Table 2-2	IP Franklin – Baseline BART Particulate Speciation.....	2-3

List of Figures

Figure 1-1	Location of Class I Areas in Relation to IP Franklin Mill.....	1-3
------------	--	-----

1.0 Introduction

1.1 Objectives

The Regional Haze Rule regulations require Best Available Retrofit Technology (BART) for any BART-eligible source that "emits any air pollutant which may reasonably be anticipated to cause or contribute to any impairment of visibility" in any mandatory Class I federal area. Pursuant to federal regulations, states have the option of exempting a BART-eligible source from the BART requirements based on dispersion modeling demonstrating that the source cannot reasonably be anticipated to cause or contribute to visibility impairment in a Class I area.

The International Paper Franklin mill (IP Franklin) has been identified as a BART eligible source. As noted above, a modeling demonstration can be used to show that a source identified as being eligible for BART requirements can be exempt if modeling shows the source does not cause or contribute to a visibility impairment as defined by the BART guideline (40 CFR Part 51, Appendix Y).

The purpose of this document is to summarize the procedures by which a modeling analysis will be conducted for the IP Franklin mill, at which the following units have been identified by the Virginia Department of Environmental Quality (DEQ) as BART eligible.

- No. 7 Power Boiler (7PB)
- Nos. 4, 5 and 6 Recovery Boilers (4RB, 5RB and 6RB)
- Nos. 4, 5 and 6 Smelt Dissolving Tanks (4SDT, 5SDT and 6SDT)
- Nos. 3 and 4 Lime Kilns (3LK and 4LK)
- Nos. 5 and 6 Lime Slaker (5LS and 6LS)
- Nos. 1, 2 and 3 Dry End Starch Silos (1SS, 2SS, and 3SS)
- Batch Digester Operation
- K1 Digester
- K2 Digester
- D, E and F Evaporator Sets

This exemption modeling analysis will determine whether the source is subject to BART requirements, and if so, describe the modeling procedure to be used for the visibility impacts factor in the BART determination step. The modeling procedures are consistent with those outlined in the final VISTAS common BART modeling protocol (updated on March 9, 2006), available at the link below:

http://www.vistas-sesarm.org/BART/BARTModelingProtocol_rev2_9Mar2006.pdf

This protocol references certain relevant portions of the common VISTAS protocol.

1.2 Location of source vs. relevant Class I Areas

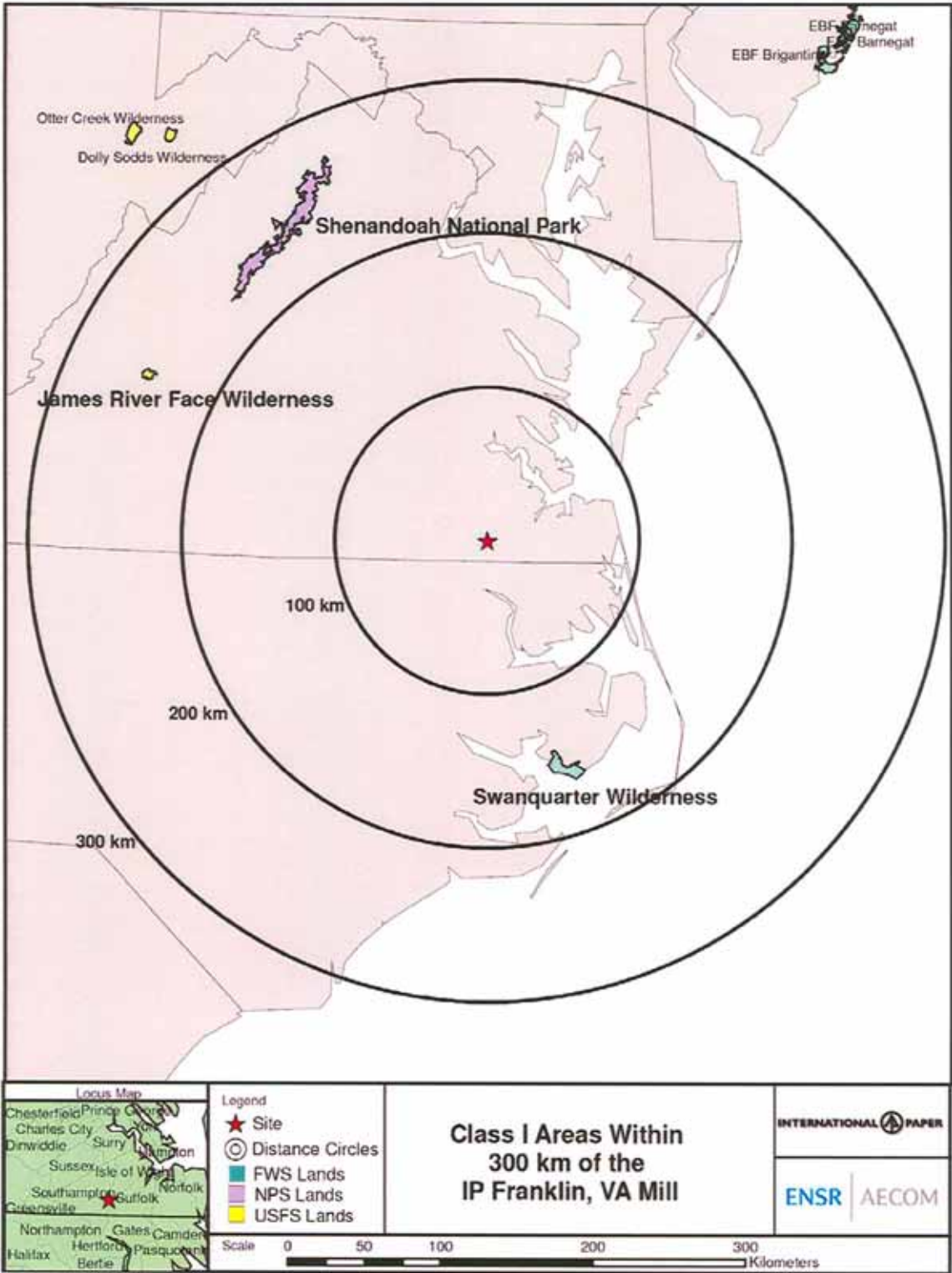
Figure 1-1 shows a plot of the IP Franklin mill relative to nearby Class I Areas. There are three Class I areas within 300 km of the plant: Swanquarter Wilderness Area (managed by the Fish and Wildlife Service), James River Face Wilderness Area (managed by the US Forest Service), and Shenandoah National Park (managed by the National Park Service). The BART exemption modeling will be conducted for each of these Class I areas in accordance with the referenced VISTAS common BART modeling protocol and the procedures

described in this source-specific BART modeling protocol. If necessary, BART determination modeling will be performed for those Class I areas where the exemption modeling shows a greater than 0.5 deciviews impact.

1.3 Organization of protocol document

Section 2 of this protocol describes the source emissions that will be used as input to the BART exemption modeling and, if necessary, the BART determination modeling. Section 3 describes the input data to be used for the modeling including the modeling domain, terrain and land use, and meteorological data. Section 4 describes the air quality modeling procedures and Section 5 discusses the presentation of modeling results. Since all of the references cited are also included in the VISTAS common BART modeling protocol, no additional references section is required in this document. Appendix A provides additional background information on the baseline source emissions, while Appendix B is reserved for additional information, if necessary at a later date, on BART control option emissions data. Information on particle speciation for pulp and paper source categories is presented in Appendix C.

Figure 1-1 Location of Class I Areas in Relation to IP Franklin Mill



2.0 Source description and emissions data

2.1 Unit-specific source data

The emissions data used to assess the visibility impacts at the Class I areas within 300 km of the subject plant are discussed in this section. The SO₂, NO_x and PM₁₀ emissions were determined by ENSR based on information provided by IP Franklin and are representative of the highest 24-hour average actual emission rate for the years 2001 to 2004. Note that VISTAS states have concluded that VOC emissions should not be subject to BART based on regional modeling showing that the impact of anthropogenic VOC sources on visibility in the VISTAS region is insignificant.

For the 2001-2004 time period, IP Franklin does not have a continuous record of emissions rates for any of the BART-eligible emission units. Consistent with previously submitted annual emissions information, actual short-term emission rates were quantified using fuel, raw material, and/or product throughput data in combination with either site-specific or published emission factors. Furthermore, neither hourly nor daily throughput data are available; the shortest time period for which throughput information is archived is monthly. Consequently, the highest actual emission rates for each unit were determined by converting the unit's highest monthly throughput rate into a daily throughput rate (dividing by the number of days in that month) and multiplying the resulting daily throughput rate by the appropriate emission factor for each pollutant.

In response to the DEQ's February 15, 2006 request for a CALPUFF modeling inventory, IP documented the modeling inventory proposed for use in the CALPUFF exemption modeling in a separate submittal to DEQ dated December 21, 2005.

Because various components of PM₁₀ emissions have different visibility extinction efficiencies, the PM₁₀ emissions are divided, or "speciated" into several components. The PM₁₀ emissions and speciation approach to be used for the modeling described in this protocol is summarized in the bullets below. Detailed information is provided in Appendix A for each of the BART-eligible units.

- Coarse (2.5 µm to 10.0 µm) and fine PM₁₀ (<2.5 µm) emissions were determined from filterable PM₁₀ emissions based on particle size data from EPA data (AP-42), when available. When EPA data were not available, the coarse and fine fractions were based on conservative assumptions, as noted in Appendix A.
- Fine EC emissions were determined as percentages of fine PM₁₀ emissions based on "best estimates" from "Catalog of Global Emissions Inventories and Emissions Inventory Tools for Black Carbon", when available. When published data were not available, conservative assumptions were used to estimate fine EC emissions.
- For the power boiler, condensible PM₁₀ emissions were determined from EPA emission factors (AP-42), coal sulfur content, and boiler capacity. For the recovery boilers, smelt dissolving tanks, and lime kilns, condensible PM₁₀ emissions were based on NCASI emission factors¹. The NCASI emission factors were applied to the maximum actual operating rates to determine hourly emission rates.

If the BART exemption modeling indicates that a BART determination is required, then IP Franklin would proceed with the BART determination using the five steps set forth in the final BART rule dated July 6, 2005. Tables 2-1 and 2-2 provide a summary of the baseline modeling emission parameters to be used in the BART CALPUFF modeling.

¹ Particulate Emissions Data for Pulp and Paper Industry Specific Sources, NCASI, February 9, 2006.

Table 2-1 IP Franklin – Baseline BART Stack Parameters and Criteria Pollutant Emissions

Source / Unit	Location UTM (Zone 17 NAD-83)		Stack Height	Base Elevation (MSL)	Diameter	Gas Exit Velocity	Stack Gas Exit Temperature	Emissions		
	UTM East	UTM North						SO ₂	NO _x	PM ₁₀
	km	km	m	ft	m	m/s	Deg K	lb/hr	lb/hr	lb/hr
7 PB	328.910	4060.808	75.61	22	4.27	8.99	459.82	687	422	15.0
4 RF	328.883	4060.903	74.39	22	2.44	13.49	422.04	468	56.9	7.19
5 RF	328.877	4060.922	74.39	22	2.52	11.84	408.71	274	51	11.2
6 RF	329.068	4060.977	92.07	22	3.47	11.24	475.37	133	85	11.8
4 SDT	328.931	4060.892	58.84	22	1.52	9.39	347.59	0.8	1.6	11
5 SDT	328.927	4060.908	58.84	22	1.52	6.10	350.93	0.7	1.4	7.2
6 SDT	329.075	4060.948	92.07	22	1.07	7.97	359.26	1.3	2.7	7.5
4 LK	328.954	4060.935	30.49	22	1.52	13.61	349.26	3.4	22.5	38.9
3 LK	328.965	4060.931	26.22	22	1.98	4.91	349.82	2.9	15.5	42.5
5 Slaker	328.996	4060.846	34.40	22	0.91	1.90	349.26			0.4
6 Slaker	328.989	4060.855	34.40	22	0.91	3.38	340.32			4.9
#1 Starch Silo	329.059	4060.543	28.3	22	0.30	4.48	296.30			0.019
#2 Starch Silo	329.065	4060.546	28.3	22	0.30	4.48	296.30			0.019
#3 Starch Silo	329.070	4060.550	28.4	22	0.30	4.48	296.30			0.019
K1 Digester	Discharges via No. 6 or No. 7 Power Boiler Stack SO ₂ only; emissions accounted for in No. 7 Power Boiler emissions							112.1		
K2 Digester								78.3		
D, E and F Evap. Sets								268.4		
Batch Digester System								124.5		

Table 2-2 IP Franklin – Baseline BART Particulate Speciation

Unit	Particle Speciation								
	Total Filterable PM ₁₀	Coarse PM ₁₀	Fine Filterable PM ₁₀			Condensible PM ₁₀			
			Total	Soil	Elemental Carbon (EC)	Total	Inorganic (Soil)	Inorganic (SO ₄)	Organic
All Values in lb/hr									
7P B&W POWER BOILER	15.00	7.00	8.00	7.44	0.56	12.57	0.00	10.06	2.51
4 RECOVERY BOILER, NONDIRECT CONTACT EVAPORATION	7.19	0.72	6.47	6.02	0.45	26.06	14.38	7.41	4.27
5R KRAFT RECOVERY FURNACE, NONDIRECT CONTACT EVAPORATION	11.20	1.12	10.08	9.37	0.71	26.88	14.83	7.64	4.41
6R KRAFT RECOVERY BOILER, DIRECT CONTACT EVAPORATION	11.80	3.45	8.35	7.77	0.58	119.52	70.07	37.73	11.73
4SDT SMELT DISSOLVING TANK	11.00	1.17	9.83	9.60	0.23	0.97	0.56	0.23	0.18
5SDT SMELT DISSOLVING TANK	7.20	0.76	6.44	6.29	0.15	1.00	0.58	0.24	0.19
6SDT SMELT DISSOLVING TANK	7.50	0.79	6.71	6.55	0.16	1.87	1.08	0.44	0.35
4LK LIME KILN	38.90	0.91	37.99	37.10	0.89	1.49	1.12	0.30	0.07
3LK LIME KILN	42.50	0.99	41.51	40.54	0.97	1.21	0.91	0.24	0.06
5SV LIME SLAKER	0.40	0.00	0.40	0.00	0.00	0.00	0.00	0.00	0.00
6SV LIME SLAKER	4.90	0.00	4.90	0.00	0.00	0.00	0.00	0.00	0.00
No. 1 Dry End Starch Silo	0.019	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
No. 2 Dry End Starch Silo	0.019	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
No. 3 Dry End Starch Silo	0.019	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Batch Digester Filling	0.007	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Notes: Detailed calculations are provided in Appendix A. Emission units in Table 2-1 that do not emit particulate matter are not included in Table 2-2.

3.0 Input data to the CALPUFF model

3.1 General modeling procedures

VISTAS has developed five sub-regional 4-km CALMET meteorological databases for three years (2001-2003). The sub-regional modeling domains are strategically designed to cover all potential BART eligible sources within VISTAS states and all PSD Class I areas within 300 km of those sources. The extents of the 4-km sub-regional domains are shown in Figure 4-4 of the VISTAS common BART modeling protocol. The BART modeling for IP Franklin will be done using the appropriate 4-km sub-domain (#5, as shown in Figure 4-4 of the VISTAS BART protocol).

USGS 90-meter Digital Elevation Model (DEM) files were used by VISTAS to generate the terrain data at 4-km resolution for input to the 4-km sub-regional CALMET run. Likewise, USGS 90-meter Composite Theme Grid (CTG) files were used by VISTAS to generate the land use data at 4-km resolution for input to the 4-km sub-regional CALMET run.

Three years of MM5 data (2001-2003) were used by VISTAS to generate the 4-km sub-regional meteorological datasets. See Sections 4.3.2 and 4.4.2 in the VISTAS common BART modeling protocol for more detail on these issues.

It is intended that all of the modeling for IP Franklin will use the 4-km sub-domain. However, if the results indicate that peak concentrations could be better predicted with a CALPUFF run using a finer grid, due to terrain, shoreline resolution, or other factors, then refinements in the modeling procedures will be considered and DEQ will be asked to approve these refinements.

In the event that a finer grid resolution is used, CALMET must be rerun. Other modifications to inputs of CALMET would include the extent of the modeling domain, the resolution of the terrain and land use data, and other relevant settings. The same MM5 data and observations as used for the 4-km sub-regional CALMET simulations would be used. The extent of the modeling domain may need to be changed because of disk space restrictions. The size of the CALMET output is directly proportional to the grid resolution of the run. The domain would be limited to the source and the exclusive Class I area(s) being assessed with a higher grid resolution, including a 50-km buffer in all directions.

If CALMET needs to be run at even a finer grid resolution, then the appropriate model setting/files (specifically the GEO.DAT file) will be modified. A summary of these modifications would be provided to DEQ for review and approval.

3.2 Air quality database (background ozone and ammonia)

Hourly measurements of ozone from all non-urban monitors, as generated by VISTAS and available on the VISTAS CALPUFF page on the Earth Tech web site (http://www.src.com/verio/download/sample_files.htm), will be used as input to CALPUFF. As for ammonia, it is intended to follow the approach recommended by VISTAS. Currently, VISTAS intends to provide hourly ammonia data, derived from CMAQ runs, for the 4-km sub-regional domain runs. If for some reason the CMAQ data is unavailable, then it is anticipated that VISTAS will recommend an alternate approach for sources to use. Two alternatives that could be considered are to use average, single-value ammonia background concentrations derived from existing references such as the 1998 IWAQM Phase 2 report (see page 14 of that report) or to use monthly-varying ammonia background values.

3.3 Natural conditions and monthly f(RH) at Class I Areas

There are three Class I areas within 300 km of IP Franklin (as noted in Figure 1-1). For each of the Class I areas, natural background conditions must be established in order to determine a change in natural conditions related to a source's emissions. For the modeling described by this protocol document, it is intended to use the natural background light extinction corresponding to the 20% best days (EPA 2003 values), consistent with the VISTAS BART protocol. However, the BART rule has an inconsistency on whether the natural background should be reflective of the average conditions rather than the 20% best days' conditions. If EPA determines that the average conditions are appropriate and Virginia DEQ adopts this position, then the CALPUFF exemption modeling will use the average background conditions for the 0.5 deciview test of contributing to visibility impairment.

To determine the input to CALPUFF, it is first necessary to convert the deciviews to extinction using the equation:

$$\text{Extinction (Mm}^{-1}\text{)} = 10 \exp(\text{deciviews}/10).$$

For example, the EPA guidance document indicates for Swanquarter Wilderness Area that the deciview value for the best 20% of days is 3.54. This is equivalent to an extinction of 14.25 inverse megameters (Mm^{-1}). In the case of average conditions, the deciview value is 7.38, which is equivalent to an extinction of 20.92 Mm^{-1} .

This extinction includes the default 10 Mm^{-1} for Rayleigh scattering. The remaining extinction is due to naturally occurring particles, and should be held constant for the entire year's simulation. Therefore, the data provided to CALPOST for Swanquarter would be the total natural background extinction minus 10 (expressed in Mm^{-1}), or 4.25, for the 20% best days case. This is most easily input as fine soil concentrations ($4.25 \mu\text{g}/\text{m}^3$) in CALPOST, since the extinction efficiency of soil (PM-fine) is 1.0 and there is no f(RH) component. The concentration entries for all other particle constituents would be set to zero, and the fine soil concentration would be kept the same for each month of the year. The monthly values for f(RH) that CALPOST needs will be taken from "Guidance for Tracking Progress Under the Regional Haze Rule" (EPA, 2003) Appendix A, Table A-3. However, it should be noted that these values correspond to the annual average background conditions, not the 20% best conditions, which would intuitively be expected to be associated with drier days than average. Therefore, IP reserves the right to adjust the f(RH) values for the 20% best days' humidity conditions if this refinement is needed.

4.0 Air quality modeling procedures

This section provides a summary of the modeling procedures outlined in the VISTAS protocol that will be used for the refined CALPUFF analysis to be conducted for IP Franklin.

4.1 Model selection and features

As noted in the VISTAS protocol, VISTAS will use the BART-specific versions of CALMET and CALPUFF that have been posted at http://www.src.com/verio/download/download.htm#VISTAS_VERSION. These versions contain enhancements funded by the Minerals Management Service (MMS) and VISTAS. They were developed by Earth Tech, Inc. and they are maintained on Earth Tech's Atmospheric Studies Group CALPUFF website for public access. This release includes CALMET, CALPUFF, CALPOST, CALSUM, and POSTUTIL as well as CALVIEW.

The major features of the CALPUFF modeling system, including those of CALMET and the post processors (CALPOST and POSTUTIL) are referenced in Section 3 of the VISTAS protocol.

4.2 Modeling domain and receptors

The initial IP Franklin BART runs will use the sub-domain 4-km CALMET data to be supplied by VISTAS, as discussed above. This domain includes all Class I areas within 300 km of the source, plus a 50-km buffer. If there is the need for a refined analysis with a finer grid, a supplement to this modeling protocol will be provided describing the proposed procedures.

The receptors used for each of the Class I areas are based on the NPS database of Class I receptors, as recommended by the VISTAS common protocol (Section 4.3.3)

4.3 Technical options used in the modeling

CALMET modeling for the VISTAS-provided 4-km sub-domains will be pre-determined by the VISTAS contractor, and, therefore, we assume that VISTAS approves of the manner in which CALMET has been run for the sub-domain data that they provide. If it is decided to conduct additional modeling with a finer grid than 4 km, this modeling protocol will be updated to specify the technical options used in the CALMET run, in order to allow for state agency review and approval.

For CALPUFF model options, IP Franklin will follow the VISTAS common BART modeling protocol (Section 4.4.1), which states that we should use IWAQM (EPA, 1998) guidance. The VISTAS protocol also notes that building downwash effects are not required to be included unless the state directs the source to include these effects. Since IP Franklin is several tens of kilometers from the nearest Class I area, we will not be including building downwash effects in the CALPUFF modeling.

The POSTUTIL utility program (described in VISTAS common protocol Section 4.4.2) will be used to repartition HNO₃ and NO₃ using VISTAS-provided ammonia concentrations derived from previous 2002 CMAQ modeling conducted by EPA, or an alternate ammonia concentrations approach recommended by VISTAS, if the CMAQ data is unavailable.

4.4 Light extinction and haze impact calculations

The CALPOST postprocessor will be used as prescribed in the VISTAS protocol for the calculation of the impact from the modeled source's primary and secondary particulate matter concentrations on light extinction. The formula that is used is the existing (not the November 2005 revised) IMPROVE/EPA formula, which is

applied to determine a change in light extinction due to increases in the particulate matter component concentrations. Using the notation of CALPOST, the formula is the following:

$$b_{ext} = 3 f(RH) [(NH_4)_2SO_4] + 3 f(RH) [NH_4NO_3] + 4[OC] + 1[Soil] + 0.6[Coarse Mass] + 10[EC] + b_{Ray}$$

The concentrations, in square brackets, are in $\mu g/m^3$ and b_{ext} is in units of Mm^{-1} . The Rayleigh scattering term (b_{Ray}) has a default value of $10 Mm^{-1}$, as recommended in EPA guidance for tracking reasonable progress (EPA, 2003a). However, as recommended in the VISTAS protocol (Section 6.2.4), for refined 4-km grid (or smaller) CALPUFF runs, the Rayleigh scattering term will be modified for the specific elevation of the Class I area receptors. For near sea-level sites, this value is generally between 11 and $12 Mm^{-1}$. Specific values can be found at vista.cira.colostate.edu/improve/Publications/GrayLit/019_RevisedIMPROVEeq/RevisedIMPROVEAlgorithm3.doc.

The assessment of visibility impacts at the Class I areas will use CALPOST Method 6 (as noted in the VISTAS common protocol Section 4.3.2). Each hour's source-caused extinction is calculated by first using the hygroscopic components of the source-caused concentrations, due to ammonium sulfate and nitrate, and monthly Class I area-specific $f(RH)$ values. The contribution to the total source-caused extinction from ammonium sulfate and nitrate is then added to the other, non-hygroscopic components of the particulate concentration (from coarse and fine soil, secondary organic aerosols, and from elemental carbon) to yield the total hourly source-caused extinction.

The BART rule significance threshold for the contribution to visibility impairment is 0.5 deciviews. The VISTAS protocol (Section 4.3.2) indicates that with the use of the 4-km sub-regional CALMET database, a source does not cause or contribute to visibility impairment if the 98th percentile (or 8th highest) day's change in extinction from natural conditions does not exceed 0.5 deciviews for any of the modeled years. As an added check, the 22nd highest prediction over the three years modeled should also not exceed 0.5 deciviews for a source to be exempted from a BART determination.

Figure 4-1 of the VISTAS common BART modeling protocol presents a flow chart showing the components of that modeling protocol for the analysis to determine whether a source is subject to BART. Again, it should be noted that the modeling for IP Franklin will focus on Sub-regional Fine-Scale modeling as depicted in the lower half of the figure.

If the exemption modeling demonstrates that the BART-eligible units at IP Franklin do not cause or contribute to visibility impairment, then IP Franklin will not be subject to BART requirements, and no further analysis is needed. Otherwise, IP will proceed to perform BART determination modeling for the baseline and each control option in a similar manner as has been described in this document.

5.0 Presentation of modeling results

The BART exemption and, if necessary, the BART determination modeling results for IP Franklin will be provided to the state agency in a manner as described in the VISTAS protocol (Section 4.5). A report will be produced that includes the following elements (as suggested in the VISTAS protocol):

1. A map of the source location and Class I areas within 300 km of the source.
2. For the CALPUFF modeling domain, a table listing all Class I areas in the VISTAS domain and those in neighboring states and impacts from the BART 4-km grid exemption modeling at those Class I areas within 300 km of the source, as illustrated in Table 4-3 of the VISTAS protocol.
3. A discussion of the number of Class I areas with visibility impairment due to source emissions for the 98th percentile days in each year (and the 98th percentile over all three years modeled) greater than 0.5 dv.
4. For the Class I area with the maximum impact, a discussion of the number of days beyond those excluded (e.g., the 98th percentile for refined analyses) that the impact of the source exceeds 0.5 dv, the number of receptors in the Class I area where the impact exceeds 0.5 dv, and the maximum impact.
5. For any finer grid CALPUFF exemption modeling, results for those Class I areas for which impacts of the source exceeded 0.5 dv in the 4-km initial modeling. We would report the same type of results as provided for 4-km exemption modeling.

The BART determination modeling, if necessary, would be performed for those Class I areas shown in the exemption modeling to exceed 0.5 dv impact. The extent of the BART determination modeling results would depend on the number of technically viable controls identified in the engineering analysis phase of the BART assessment. The results presented would be a comparison of the 98th percentile value for the baseline and each control strategy derived as is outlined above for the exemption modeling. The same statistics as those mentioned above in Steps 3 and 4 would be provided, and a summary of the relative results among all emission scenarios run would be produced.

Additionally, the appropriate electronic files used to conduct the CALPUFF modeling will be submitted on CD-ROM or DVD media.

Appendix A:

Source-Specific Emissions Data for BART Baseline Case

Source-Specific Emissions Data for BART Baseline Case

EMISSION UNIT ID	EMISSION UNIT DESCRIPTION	EMISSION PROCESS DESCRIPTION	MAX ACTUAL DAILY OPERATING RATE (MMBtu/hr, ton BLS/hr, or dscfm) (2001-2004)	CONTROL DEVICE	SHORT TERM EMISSIONS, lb/hr (for the highest emitting day)											
					PM 10		Total PM ₁₀ Emissions (filterable + condensable)	PM ₁₀ Emissions					Condensable			
					POTENTIAL	ACTUAL (a)		Filterable					CPM IOR			
								Total	Coarse	Fine Total	Fine Soil	Fine Elemental Carbon	Total	Soil	Sulfates	CPM IOR
4	7P B&W POWER BOILER (a)	7P B&W-BIT COAL	233 MMBtu/hr	Electrostatic Precipitator	9.40	15.00	27.57	15.00	7.00 (c)	8.00 (c)	7.44	0.56 (d)	12.57 (e)	0.00 (e)	10.06 (e)	2.51 (e)
		7P B&W #6 OIL BOILER		Electrostatic Precipitator	0.90											
		7P B&W Wood		Electrostatic Precipitator	16.30											
		7P B&W-TRS GASES		Combustion												
6	4 RECOVERY BOILER, NONDIRECT CONTACT EVAPORATION	4R KRAFT RECOVERY FURNACE	41.1 ton BLS/hr	Electrostatic Precipitator	5.50	7.19	33.25	7.19	0.72 (f)	6.47 (f)	0.02 (g)	0.43 (g)	26.06 (h)	14.35 (h)	7.41 (h)	4.27 (h)
		4R IN PROCESS FUELS-OIL		Electrostatic Precipitator	0.10											
7	5R KRAFT RECOVERY FURNACE, NONDIRECT CONTACT EVAPORATION	5R KRAFT RECOVERY FURNACE	42.4 ton BLS/hr	Electrostatic Precipitator	12.60	11.20	38.05	11.2	1.12 (f)	10.08 (f)	0.37 (g)	0.71 (g)	26.88 (h)	14.83 (h)	7.64 (h)	4.41 (h)
		5R IN PROCESS FUELS-OIL		Electrostatic Precipitator	0.10											
8	6R KRAFT RECOVERY BOILER, DIRECT CONTACT EVAPORATION	6R KRAFT RECOVERY FURNACE	79.3 ton BLS/hr	Electrostatic Precipitator	13.70	11.80	131.32	11.8	3.45 (f)	8.35 (f)	7.77 (g)	0.58 (g)	119.52 (j)	70.07 (j)	37.73 (j)	11.73 (j)
		6R IN PROCESS FUELS-OIL		Electrostatic Precipitator	0.30											
9	4SDT SMELT DISSOLVING TANK	4SDT SMELT DISSOLVING TK	41.1 ton BLS/hr	Wet Scrubber	11.50	11.00	11.97	11.00	1.17 (k)	9.83 (k)	0.60 (l)	0.23 (l)	0.97 (m)	0.56 (m)	0.23 (m)	0.18 (m)
10	5SDT SMELT DISSOLVING TANK	5SDT SMELT DISSOLVING TK	42.4 ton BLS/hr	Wet Scrubber	8.20	7.20	8.20	7.20	0.78 (k)	6.44 (k)	0.29 (l)	0.15 (l)	1.00 (m)	0.56 (m)	0.24 (m)	0.19 (m)
11	6SDT SMELT DISSOLVING TANK	6SDT SMELT DISSOLVING TK	79.3 ton BLS/hr	Wet Scrubber	8.60	7.50	9.37	7.50	0.79 (k)	6.71 (k)	0.55 (l)	0.16 (l)	1.87 (m)	1.06 (m)	0.44 (m)	0.35 (m)
12	4LK LIME KILN	4LK LIME KILN	27.516 dscfm	Wet Scrubber	47.60	38.60	40.30	38.60	0.91 (m)	37.69 (m)	37.10 (n)	0.89 (n)	1.49 (o)	1.12 (o)	0.30 (o)	0.07 (o)
14	3LK LIME KILN	3LK LIME KILN	22.370 dscfm	Wet Scrubber	53.00	42.50	43.71	42.50	0.99 (m)	41.51 (m)	40.54 (n)	0.97 (n)	1.21 (o)	0.91 (o)	0.24 (o)	0.06 (o)
23	5SV LIME SLAKER	5SV LIME SLAKER	41.7 ADTP/hr	Venturi Scrubber	0.70	0.40	0.40	0.40	0	0.40 (p)	0	0	0	0	0	0
24	6SV LIME SLAKER	6SV LIME SLAKER	40.9 ADTP/hr	Venturi Scrubber	6.90	4.90	4.90	4.90	0	4.90 (p)	0	0	0	0	0	0
	No. 1 Dry End Starch Silo	No. 1 Dry End Starch Silo		Fabric Filter	0.019	0.019	0.02	0.019	0	0.02 (p)	0	0	0	0	0	0
	No. 2 Dry End Starch Silo	No. 2 Dry End Starch Silo		Fabric Filter	0.019	0.019	0.02	0.019	0	0.02 (p)	0	0	0	0	0	0
	No. 3 Dry End Starch Silo	No. 3 Dry End Starch Silo		Fabric Filter	0.019	0.019	0.02	0.019	0	0.02 (p)	0	0	0	0	0	0
	Batch Digester Filling	Batch Digester Filling			0.007	0.007	0.01	0.007	0	0.01 (p)	0	0	0	0	0	0

Includes only those BART-eligible sources at the mill that emit particulate matter.

(a) Highest hourly actual emissions are based on the operating period between years 2001 and 2004. These emissions values are the highest values for each unit for that period.

(b) Particle size and condensable emissions are based on coal combustion.

(c) Coarse PM₁₀ is (1-0.45/0.75) x filterable PM₁₀; based on Table 1.1-7 in AP-42. Fine PM₁₀ is the difference between filterable PM₁₀ and coarse PM₁₀.

(d) 7.0% of fine PM₁₀, based on the average of the best estimates for industrial coal and wood combustion in Table 6 of "Catalog of Global Emissions Inventories and Emission Inventory Tools for Black Carbon", William Battye and Kathy Boyer, EPA Contract No. 68-D-96-048, January 2002.

(e) Condensable PM₁₀, based on AP-42, Table 1.1-5 and boiler capacity. Total condensable PM₁₀ = 0.15-0.03 lb/MMBtu. Inorganic is 60% of total and organic is 20% of total. Inorganics assumed to be sulfates. Coal during the period of maximum emissions contained 0.84% S.

(f) Coarse PM₁₀ is (1-0.67/0.70) x filterable PM₁₀; based on Table 1.1-7 in AP-42. Fine PM₁₀ is the difference between filterable PM₁₀ and coarse PM₁₀.

(g) There are no data on elemental or black carbon (EC) for this source type. Emissions are based on 7% of fine PM₁₀. This assumption is based on the "best estimate" of 6.7% for natural gas combustion and 7.4% for oil in Table 6 of "Catalog of Global Emissions Inventories and Emission Inventory Tools for Black Carbon", William Battye and Kathy Boyer, EPA Contract No. 68-D-96-048, January 2002.

(h) Condensable PM₁₀ (CPM) emissions are based on NCASI emission factors (Particulate Emissions for Pulp and Paper Industry Specific Sources, February 9, 2006). This is a nondirect contact evaporation recovery furnace. The emissions factors are 0.53 lb/ton of BLS for CPM Inorganic (IOR) and 0.104 lb/ton of BLS for CPM organic (OR). Sulfates, based on ion chromatography, are 34% of the CPM IOR.

(i) Coarse PM₁₀ is (1-0.55/0.76) x filterable PM₁₀; based on Table 10.2-2 in AP-42. 76% of filterable PM₁₀ as filterable PM₁₀ is extrapolated from Figure 10.2-2. Fine PM₁₀ is the difference between filterable PM₁₀ and coarse PM₁₀.

(j) Condensable PM₁₀ emissions are based on NCASI emission factors (Particulate Emissions for Pulp and Paper Industry Specific Sources, February 9, 2006). This is a direct contact evaporation recovery furnace. The emissions factors are 1.36 lb/ton of BLS for CPM IOR and 0.148 lb/ton of BLS for CPM OR. Sulfates, based on ion chromatography, are 35% of the CPM IOR.

(k) Coarse PM₁₀ is (1-0.65/0.953) x filterable PM₁₀; based on Table 10.2-6 in AP-42. Fine PM₁₀ is the difference between filterable PM₁₀ and coarse PM₁₀.

(l) There are no data on EC for this source type. PM₁₀ emissions from smelt tanks and lime kilns are nearly virtually all inorganic given the nature of the processes. (herein, as a conservative estimate, it is assumed that 2.33% of the PM₁₀ is EC or the percentage assumed for the recovery coaters) is EC.

(m) Condensable PM₁₀ emissions are based on NCASI emission factors (Particulate Emissions for Pulp and Paper Industry Specific Sources, February 9, 2006). The emissions factors are 0.0192 lb/ton of BLS for CPM IOR and 0.0044 lb/ton of BLS for CPM OR. Sulfates, based on ion chromatography, are 29% of the CPM IOR.

(n) Coarse PM₁₀ is (1-0.96/0.983) x filterable PM₁₀; based on Table 10.2-4 in AP-42. Fine PM₁₀ is the difference between filterable PM₁₀ and coarse PM₁₀.

(o) Condensable PM₁₀ emissions are based on NCASI emission factors (Particulate Emissions for Pulp and Paper Industry Specific Sources, February 9, 2006). The emissions factors are 0.0060 gr/dscf @ 10% O₂ for CPM IOR and 0.00030 gr/dscf @ 10% O₂ for CPM OR. Sulfates, based on ion chromatography, are 21% of the CPM IOR. Stack gas flow is calculated from the stack parameters assuming saturation and 10% O₂ on a dry basis.

(p) All PM₁₀ is conservatively assumed to be fine PM₁₀. Based on the type of source, these sources are not expected to emit EC or CPM.

Appendix B:

Source-Specific Emissions Data for BART Determination Options (Reserved)

Appendix C:

NCASI Particle Speciation Data

Particulate Emissions Data for Pulp and Paper Industry Specific Sources

The following tables contain summarized particulate emissions data for sources that are specific to the pulp and paper industry. The source categories addressed in this document are smelt dissolving tanks, lime kilns, and recovery furnaces. Boilers are not addressed since AP-42 emission factors for boiler emissions are well documented and readily available including in NCASI Technical Bulletin No. 884.

Smelt Dissolving Tanks

Data for smelt dissolving tanks were compiled from NCASI Technical Bulletins Nos. 884 and 898. This data set includes test results from the use of a dilution tunnel method which quantifies total PM₁₀ and PM_{2.5} particulate matter. Total PM₁₀ and PM_{2.5} particulate matter are the sum of filterable and condensable PM₁₀ and PM_{2.5} particulate matter. All smelt dissolving tanks in the data set have wet particulate control devices.

The filterable PM numbers are obtained from combining the data set of 36 sources listed in NCASI Technical Bulletin No. 884, Table A15c, and the data set of 6 sources listed in NCASI Technical Bulletin No. 898. The data for "Total PM₁₀" and "Total PM_{2.5}" are from the 8 sources listed in NCASI Technical Bulletin No. 884, Table A15d. All of the CPM data was from the 6 sources listed in NCASI Technical Bulletin No. 898. The CPM data listed in Technical Bulletin No. 884 was not used as that data is an estimate of CPM and not results from EPA Method 202. All of the sulfate data is from the 3 sources tested by NCASI, and listed in Technical Bulletin No. 898.

Table 1: Smelt Tank Data Summary

Parameter	Measurement Method	No. of Sources	Range (lb/ton BLS)	Mean	⁵ Mean Percent of PM
PM	EPA Method 5	42	0.03 - 0.64	0.148	
⁶ Total PM ₁₀	Dilution Tunnel	8	¹ 0.031 - 0.666	² 0.154	⁶ 104
⁶ Total PM _{2.5}	Dilution Tunnel	7	¹ 0.027 - 0.570	² 0.132	⁶ 89
CPM MeCl ₂ Soluble	EPA 202	6	¹ 0.0009 - 0.0192	² 0.0044	3
CPM Water Soluble	EPA 202	6	¹ 0.0039 - 0.0832	² 0.0192	13
CPM	EPA Method 202	6	¹ 0.0048 - 0.1024	² 0.0237	16
Sulfate	IC	3	³ 0.0014 - 0.0297	⁴ 0.0069	% of CPM = 29

¹Range values were determined by applying the mean percent of PM to the range of values for PM. ²Mean values were determined by applying the mean percent of PM to mean value for PM. ³Range values for sulfate were determined by applying the mean percent of CPM to the range of CPM values. ⁴Mean value for sulfate was determined by applying the mean percent of CPM to the mean value for CPM. ⁵Mean percent of PM values are derived from individual data sets. ⁶Values include filterable and condensable PM.

Recovery Furnaces

The recovery furnace data are a compilation of data in NCASI Technical Bulletins Nos. 852, 884, and as yet unpublished NCASI data. All of the recovery furnaces in this data set use electrostatic precipitators (ESP) for particulate control.

The PM data for DCE recovery furnaces is from the 23 sources listed in NCASI Technical Bulletin No. 884, Table A11c. The PM_{10} data for the DCE recovery furnaces is from the 4 DCE sources listed in Technical Bulletin No. 884, Table A11d. The $PM_{2.5}$ data for DCE recovery furnaces is from the 4 DCE sources listed in Technical Bulletin No. 884, Table A11d, plus a further two from as yet unpublished NCASI data. The DCE CPM data is from two sources listed in Technical Bulletins Nos. 852 and 884, and two sources from as yet unpublished NCASI data.

The PM data for the NDCE recovery furnaces is from the 20 sources listed in NCASI Technical Bulletin No. 884, Table A12b. The PM_{10} data for the NDCE recovery furnaces is from the 13 NDCE sources listed in Technical Bulletin No. 884, Table A12c. The $PM_{2.5}$ data for NDCE recovery furnaces is from the 11 DCE sources listed in Technical Bulletin No. 884, Table A12c, plus a further source from as yet unpublished NCASI data. The NDCE CPM data is from 6 sources listed in Technical Bulletin No. 884, and one source from as yet unpublished NCASI data.

Table 2: Recovery Furnace Data Summary

Kraft DCE Recovery Furnace					
Parameter	Measurement Method	No. of Sources	Range (lb/ton BLS)	Mean	⁵ Mean Percent of PM
PM	EPA Method 5	23	0.07 - 2.58	0.74	
PM ₁₀	EPA CTM-040	4	¹ 0.05 - 1.88	² 0.54	73
PM _{2.5}	EPA CTM-040	6	¹ 0.04 - 1.44	² 0.41	56
CPM MeCl ₂ Soluble	EPA 202	4	¹ 0.014 - 0.516	² 0.148	20
CPM Water Soluble	EPA 202	4	¹ 0.13 - 4.75	² 1.36	184
CPM	EPA Method 202	4	¹ 0.14 - 5.29	² 1.52	205
Sulfate	IC	3	³ 0.05 - 1.85	⁴ 0.53	% of CPM = 35
Kraft NDCE Recovery Furnace					
Parameter	Measurement Method	No. of Sources	Range (lb/ton BLS)	Mean	⁵ Mean Percent of PM
PM	EPA Method 5	20	0.02 - 3.50	0.65	
PM ₁₀	EPA CTM-040	13	¹ 0.01 - 2.35	² 0.44	67
PM _{2.5}	EPA CTM-040	11	¹ 0.01 - 1.82	² 0.34	52
CPM MeCl ₂ Soluble	EPA 202	3	¹ 0.003 - 0.560	² 0.104	16
CPM Water Soluble	EPA 202	3	¹ 0.016 - 2.84	² 0.53	81
CPM	EPA Method 202	7	¹ 0.02 - 3.40	² 0.63	97
Sulfate	IC	2	³ 0.007 - 1.16	⁴ 0.21	% of CPM = 34

¹Range values were determined by applying the mean percent of PM to the range of values for PM. ²Mean values were determined by applying the mean percent of PM to the mean value for PM. ³Range values for sulfate were determined by applying the mean percent of CPM to the range of CPM values. ⁴Mean value for sulfate was determined by applying the mean percent of CPM to the mean value for CPM. ⁵Mean percent of PM values are derived from individual data sets.

Lime Kilns

The lime kiln data are a compilation of data from NCASI Technical Bulletins Nos. 852, 884, and 898. The emissions data are separated by control device type. The majority of lime kilns in this data set use wet control devices for particulate control. Two of the lime kilns in this data set use an ESP for particulate control, followed by a wet scrubber for SO₂ control. The remainder use an ESP for particulate control.

The PM data for lime kilns using wet control devices is from 30 sources listed in NCASI Technical Bulletin No. 884, Table A13c. The PM₁₀ and PM_{2.5} data for lime kilns using wet control devices is from NCASI Technical Bulletin No. 884, Table A13d. The CPM and sulfate data for lime kilns using wet control devices is from Technical Bulletin No. 898.

All of the PM, CPM, and sulfate data for lime kilns using an ESP followed by a wet control device is from two sources listed in NCASI Technical Bulletin No. 898.

The PM data for lime kilns using an ESP alone are from the 7 sources listed in NCASI Technical Bulletin No. 884, Table A13c. The PM₁₀ and PM_{2.5} data are from the 6 sources listed in Technical Bulletin No. 884, Table A13d. The CPM and sulfate data are from 3 sources listed NCASI Technical Bulletin Nos. 852 and 884.

Table 3: Lime Kiln Data Summary

Lime Kilns with Wet Particulate Control Devices					
Parameter	Measurement Method	No. of Sources	Range (gr/dscf) @10% O ₂	Mean	⁵ Mean Percent of PM
PM	EPA Method 5	30	0.014 - 0.346	0.0995	
⁶ Total PM ₁₀	Dilution Tunnel	6	¹ 0.014 - 0.349	² 0.100	101
⁶ Total PM _{2.5}	Dilution Tunnel	7	¹ 0.012 - 0.304	² 0.088	88
CPM MeCl ₂ Soluble	EPA Method 202	3	¹ 4.2E-5 - 0.0010	² 0.0003	0.3
CPM Water Soluble	EPA Method 202	3	¹ 0.0008 - 0.0208	² 0.0060	6
CPM	EPA Method 202	3	¹ 0.0009 - 0.0218	² 0.0063	6.3
Sulfate	IC	2	³ 0.0002 - 0.0046	⁴ 0.0013	% of CPM = 21
*These data are the result of dilution tunnel testing, therefore the PM ₁₀ and PM _{2.5} values reflect the sum of filterable and condensable PM ₁₀ and PM _{2.5} particulate.					
Lime Kilns with a Dry ESP for Particulate Control Followed by a Wet Scrubber					
Parameter	Measurement Method	No. of Sources	Range (gr/dscf) @10% O ₂	Mean	⁵ Mean Percent of PM
PM	EPA Method 5	2	0.003 - 0.004	0.004	
PM ₁₀			No Data	No Data	
PM _{2.5}			No Data	No Data	
CPM MeCl ₂ Soluble	EPA Method 202	2	0.0004 - 0.0081	0.0042	140
CPM Water Soluble	EPA Method 202	2	0.0038 - 0.0054	0.0046	131
CPM	EPA Method 202	2	0.006 - 0.012	0.009	271
Sulfate	IC	1	0.002	0.002	% of CPM = 34
Lime Kilns with a Dry ESP for Particulate Control					
Parameter	Measurement Method	No. of Sources	Range (gr/dscf) @10% O ₂	Mean	⁵ Mean Percent of PM
PM	EPA Method 5	7	0.002 - 0.033	0.010	
PM ₁₀	EPA CTM-040	6	¹ 0.001 - 0.211	² 0.006	64
PM _{2.5}	EPA CTM-040	6	¹ 0.0005 - 0.0079	² 0.0024	24
CPM MeCl ₂ Soluble	EPA Method 202	3	¹ 0.0013 - 0.0208	² 0.0063	63
CPM Water Soluble	EPA Method 202	3	¹ 0.003 - 0.045	² 0.014	137
CPM	EPA Method 202	3	¹ 0.004 - 0.066	² 0.020	200
Sulfate	IC	3	³ 0.0035 - 0.0581	⁴ 0.0176	% of CPM = 88

¹Range values were determined by applying the mean percent of PM to the range of values for PM. ²Mean values were determined by applying the mean percent of PM to the mean value for PM. ³Range values for sulfate were determined by applying the mean percent of CPM to the range of CPM values. ⁴Mean value for sulfate was determined by applying the mean percent of CPM to the mean value for CPM. ⁵Mean percent of PM values are derived from individual data sets. ⁶Values include filterable and condensable PM.

U.S. Locations

AK, Anchorage
(907) 561-5700

AK, Fairbanks
(907) 452-5700

AL, Birmingham
(205) 980-0054

AL, Florence
(256) 767-1210

CA, Alameda
(510) 748-6700

CA, Camarillo
(805) 388-3775

CA, Orange
(714) 973-9740

CA, Sacramento
(916) 362-7100

CO, Ft. Collins
(970) 493-8878

Ft. Collins Tox Lab
(970) 416-0916

CT, Stamford
(203) 323-6620

CT, Willington
(860) 429-5323

FL, St. Petersburg
(727) 577-5430

FL, Tallahassee
(850) 385-5006

GA, Norcross
(770) 381-1836

IL, Chicago
(630) 836-1700

IL, Collinsville
(618) 344-1545

LA, Baton Rouge
(225) 298-1206

MA, Air Laboratory
(978) 772-2345

MA, Sagamore Beach
(508) 888-3900

MA, Westford
(978) 589-3000

MA, Woods Hole
(508) 457-7900

MD, Columbia
(410) 884-9280

ME, Portland
(207) 773-9501

MI, Detroit
(269) 385-4245

MN, Minneapolis
(952) 924-0117

NC, Charlotte
(704) 529-1755

NC, Raleigh
(919) 872-6600

NH, Gilford
(603) 524-8866

NJ, Piscataway
(732) 981-0200

NY, Albany
(518) 453-6444

NY, Rochester
(585) 381-2210

NY, Syracuse
(315) 432-0506

NY, Syracuse Air Lab
(315) 434-9834

OH, Cincinnati
(513) 772-7800

PA, Langhorne
(215) 757-4900

PA, Pittsburgh
(412) 261-2910

RI, Providence
(401) 274-5685

SC, Columbia
(803) 216-0003

TX, Dallas
(972) 509-2250

TX, Houston
(713) 520-9900

VA, Chesapeake
(757) 312-0063

WA, Redmond
(425) 881-7700

WI, Milwaukee
(262) 523-2040

Headquarters
MA, Westford
(978) 589-3000

Worldwide Locations

Azerbaijan
Belgium
Bolivia
Brazil
Canada
China
France
Germany
Ireland
Italy
Japan
Malaysia
Philippines
Thailand
Turkey
United Kingdom
Venezuela

www.ensr.aecom.com